



Pacific Island Network Vital Signs Monitoring Plan: Phase III Report

Appendix A: Puukohola Heiau National Historic Site Resource Overview

Page Else (HPI-CESU)

Pacific Island Network (PACN)

Territory of Guam

War in the Pacific National Historical Park (WAPA)

Commonwealth of the Northern Mariana Islands

American Memorial Park, Saipan (AMME)

Territory of American Samoa

National Park of American Samoa (NPSA)

State of Hawaii

USS Arizona Memorial, Oahu (USAR)

Kalaupapa National Historical Park, Molokai (KALA)

Haleakala National Park, Maui (HALE)

Ala Kahakai National Historic Trail, Hawaii (ALKA)

Puukohola Heiau National Historic Site, Hawaii (PUHE)

Kaloko-Honokohau National Historical Park, Hawaii (KAHO)

Puuhonua o Honaunau National Historical Park, Hawaii (PUHO)

Hawaii Volcanoes National Park, Hawaii (HAVO)

<http://science.nature.nps.gov/im/units/pacn/monitoring/plan/>

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EXECUTIVE SUMMARY & INTRODUCTION

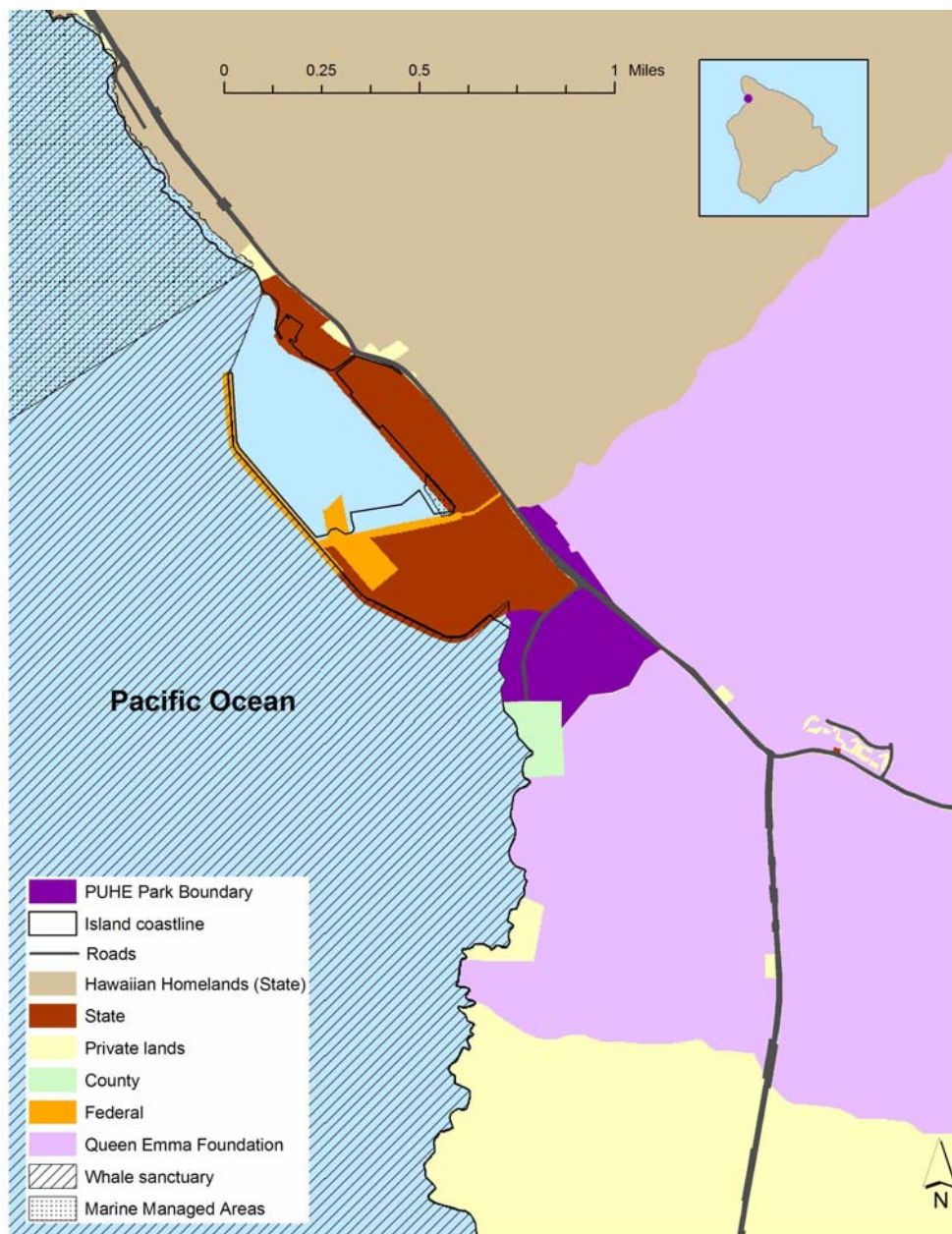
Enabling Legislation

The enabling legislation for Puukohola Heiau NHS (Pub Law 92-388 (86 Stat. 562)) allows for the acquisition of land not to exceed 100 acres "In order to restore and preserve in public ownership the historically significant temple associated with Kamehameha the Great, who founded the historic Kingdom of Hawaii, and the property of John Young who fought for Kamehameha the Great during the period of his ascendancy to power." In 1990, a donation of 26.5 acres from the Queen Emma Foundation increased the park lands to 80 acres which in turn was increased to 86 acres in 1996, in order to accommodate road realignment protecting the heiau's.

To find enabling legislation documents on-line follow the "Policy & Legislation" link from the Pacific Island Network website (www1.nature.nps.gov/im/units/pacn).

Geographic Setting

Puukohola Heiau NHS is a coastal park located on a bluff overlooking Pelekane Bay and Kawaihae Harbor in South Kohala on the Island of Hawaii (see map below). This area lies on the northwestern, leeward side of the island, which tends to be low in precipitation (8 inches average per year). The surrounding watershed is arid land with sparse vegetation dominated by exotic grasses and exotic kiawe (*Prosopis pallida*) trees. Two streams flow through the park in the rainy season, converging in the park, and reaching the ocean only when flow is high. Puukohola Heiau NHS is bordered on the north by a boat harbor and commercial shipping facilities. The harbor is currently the major shipping and freight terminus for the west side of the island. It is anticipated that this activity will continue to build as the west side develops, and military capacity increases. To the south lies a county park with beach access and camping, the Samuel M. Spencer Park. A county road is located just inside the northeastern boundary and the western coastal boundary borders a shallow harbor partially enclosed by a coral stone breakwater.



Significant Natural and Cultural Resources

Puukohola Heiau NHS is home to native plants such as pili grass (*Heteropogon contortus*), uhaloa (*Waltheria indica*), and the pololei (*Ophioglosson polyphyllum*, formerly *concinnum*) fern. A stream channel which originates upslope of the park, tidal influx, and underground springs help nourish a small pond and mixohaline wetland area providing habitat to night herons (aukuu, *Nycticorax nycticorax hoactii*), many freshwater plants, and seashore birds. The adjacent bay is home to a variety of fish, and sharks.

Park staff have planted endangered native plants, such as the loulu palm (*Pritchardia affinis*), a hibiscus (mao hau hele, *Hibiscus brackenridgei*), and ohai (*Sesbania tomentosa*). Park staff have sighted the endangered hoary bat (*Lasiurus cinereus semotus*), and the Hawaiian owl or pueo (*Asio flammeus sandwichensis*), a species of concern, but their presence is not confirmed in the park. Threatened green sea turtles (*Chelonia mydas*) are sighted frequently at the adjacent Spencer Beach Park, and sometimes rest on the beach in the Pelekane area.

Puukohola Heiau is the primary resource of Puukohola Heiau NHS, commemorating the dominance of Kamehameha the Great and his rise to power. The older Mailekini Heiau is also an important archeological resource and the John Young Homestead represents the alliance between Kamehameha and a Westerner, and the beginning influences of Western building and technology. Many other cultural resources are yet to be discovered under the vegetative overgrowth.

Resource Management Priorities

The heiau walls and surrounding grounds are overgrown with alien plant species. The overgrowth threatens the stability of the Hawaiian dry laid masonry. Sonic impacts from overflights and highway traffic, and unauthorized visitor explorations also can threaten the stability of the walls. Rats and mongoose sometimes nest in the walls. Exotic plant invasions are both a threat to the natural, cultural, and historic integrity of the park.

Upland erosion and subsequent sedimentation is a primary concern to the park's adjacent wetland and marine areas. Removal of invasive species, such as tilapia (*Oreochromis* sp.) fish, from the brackish pool is vital to the health of native species. The groundwater and tidal flow maintaining the wetland is threatened by upland erosion caused by ranching and other development and harbor pollution. Additional management concerns for the marine area include establishment of monitoring programs for turtles, fish, and sharks, and protocols for monitoring the deposition of sediment on the adjacent reef.

Opportunities for management partnerships are being sought through the Hawaiian Charter School, Mauna Kea Soils and Conservation District, and the Royal Court Assembly, which is an important source of caretaking volunteers.

NATURAL RESOURCES

Focal Ecosystems, Processes and Species

- Control of exotic species, protection and restoration of the historic vegetation
- Estuarine, riparian, and brackish water systems; inventory and restoration
- Marine Community: establishing health and value, particularly for reef black tip sharks, green turtles and coral

Vegetation: The native plant community at PUHE has been seriously compromised by exotic species invasions. Most native plants now in the park have been planted by staff. A native fern, pololei (*Ophioglosson polyphyllum*, formerly *concinnum*), was a candidate for the Federal list of endangered species until 1993, but has since been determined to be a more cosmopolitan species than originally thought (Smith, 1996). Pili grass (*Heteropogon contortus*) once dominated the arid landscape but has since been supplanted by introduced grasses.

Terrestrial Vertebrates: The stream outlet and riparian zone provides feeding and resting sites for migratory shorebirds, night herons, and other birds. The pueo (*Asio flammeus sandwichensis*) has been sighted by park staff. A family of black-crowned night herons (*aukuu*, *Nycticorax nycticorax hoactii*) lives in the riparian area.

Most terrestrial vertebrates other than birds are exotic introductions. Mongoose and feral cats are common. Goats, sheep, chicken, and rats may occasionally be present. The blind snake (*Ramphotyphlops braminus*) is present in the park, along with the house gecko (*Hemidactylus frenatus*).

Terrestrial Invertebrates: The invertebrate fauna is almost entirely introduced due to the lack of native vegetation and the presence of ants. A survey in 1992 (unpublished) found only two indigenous species (a water-breeding fly and a dragonfly), and no endemics.

Freshwater Communities: The waters of the Pelekane area are not formally part of the park, but are managed through a memorandum of understanding with the State. The freshwater system at PUHE has been heavily compromised by human disturbance. However, there are remnants of the system which still provide valuable habitat. Freshwater in West Hawaii is primarily supplied by subterranean flow from the mountain slopes to the coast. The water comes to the surface in coastal areas through shoreline seeps and springs. Stream channels contain surface water only in periods of high flow, especially in modern times, due to upslope diversions.

The Pelekane area contains an interesting hydrological system with an old stream channel entering the ocean. The channel is dry of freshwater throughout most of the year, but has some freshwater seeps. The channel is currently dominated by tidal influx and extends several hundred feet inshore, providing riparian/wetland habitat for birds, and small fish. During some years, depending on weather conditions and rainfall extent, a summer sandbar forms across the mouth of the channel, and a pond forms behind the bar. During

winter storms and rainfall the sandbar is washed away and the system is open to the ocean. There may be a shift in the biotic community accompanying this change in dynamics, which should be studied. There is also an unnamed small brackish water pool in an adjacent dry gulch bed that is separated from the main channels by a service roadway. Tidal flow infiltrates the pond under the road fill. Freshwater seeps come into the pond and modify the salinity. The pond contains fish fry but has exotic fish predators inhabiting it.

Marine Communities: The enabling legislation intended that the waters of Pelekane Bay be part of the park, but the state retains management of the marine waters. These waters provide an important adjacent resource and visitor attraction for the park. Pelekane Bay historically has been a gathering spot for sharks, especially reef black-tips (*Carcharhinus limbatus*). Observers speculate that the Bay may be a nursery area for the sharks or the attraction may be warm waters and congregating prey schools of mullet. The coral reefs in the area were some of the most developed on the island but were severely damaged by dredging for use in harbor construction. The remaining coral near the shoreline is subjected to high turbidity levels and algal overgrowth, but still maintains some fish populations, and provides feeding areas for green turtles. The offshore coral remains in better condition.

Threatened and Endangered Species: The endangered palm, loulu (*Pritchardia affinis*), and the mao hau hele (*Hibiscus brackenridgei*) have been planted in the park. Park staff report sightings of the Hawaiian hoary bat (*Lasiurus cinereus semotus*) in the park, but its presence has not been confirmed. The Inventory and Monitoring program conducted an inventory for bats in 2005 with only one sighted, in the adjacent Spencer Beach parking lot.

Threats & Stressors

- Spread of alien species, including exotic plants, predatory fish, and small mammals
- Surrounding development impacts (resorts, golf courses, military base traffic, grazing and erosion)
- Harbor expansion and associated water and air pollution
- Fishing and over-collecting in marine waters adjacent to park
- General visitor impacts, such as trampling, erosion
- Potential climatic impacts such as stream flooding and sea level rise
- Wildfire

The spread of alien species has already had a huge impact on the integrity of the historical conditions at PUHO, and makes it difficult to protect and restore both the natural and cultural resources. Urban development is increasing in the surrounding areas, and in the harbor. The increased population places more pressure on the marine resources.

Vegetation: Only the coastal strand and brackish pool support native vegetation within the park (excepting plantings of native species near Headquarters buildings). Four distinct plant communities have been recognized at Puukohola Heiau NHS: a xerophytic scrub savannah, a closed kiawe forest, a halophytic scrub, and a disturbed roadside community. The xeric, open scrub-grassland environment is the predominant plant community type. It is dominated by invasive species such as buffelgrass, feathery pennisetum, and scattered low stature shrubs of kiawe. These species not only outcompete native plants, they contribute to other stressors, such as the threat of wildfire (buffelgrass) and depletion of groundwater resources (kiawe). Three alien species found within the park are considered noxious weeds, including fountain grass (*Pennisetum setaceum*), puncture vine (*Tribulus terrestris*), and Sacramento bur (*Triumfetta semitriloba*).

Terrestrial Vertebrates: Mongoose and feral cats are common in the park. They prevent the reestablishment of native species. Goats, sheep, and chicken have been sighted in the park on occasion.

Freshwater Communities: Exotic predatory fish now dominate the brackish water pond.

Water Quality Designations

Marine waters and marine bottom ecosystems occurring in the nearshore areas adjacent to PUHE are classed as “A” and “II”, respectively; protecting their use for recreational and aesthetic enjoyment by regulating discharges and human alteration. Adjacent to PUHE, Pelekane Bay/Kawaihae Harbor is listed as impaired due to turbidity exceedances and Spencer Park Beach has demonstrated impairments due to high turbidity and chlorophyll *a* (Hawaii State DOH 2004).

The Pelekane Bay watershed was identified in Hawaii’s Unified Watershed Assessment as a Category I watershed: placing it as one of the State’s watersheds in most urgent need of restoration. The cause is development activities, such as grazing in the upper watershed, which have led to erosion and sedimentation. Water quality measurements at surrounding beaches suggest that sewage and other contaminants may pose risks to human bathers (National Park Service 2001).

CULTURAL ISSUES

- Preservation of historic structures and vegetation
- Preservation of traditional uses of the site

One of the primary management goals of the park is to maintain the historic scene of the park as it was during the height of King Kamehameha’s reign. The spread of exotic vegetation threatens the native plants and the Polynesian introductions cultivated for food. The exotic plants threaten the structural integrity of the rock walls, and the introduced grasses heighten the threat of wildfire.

MANAGEMENT ISSUES

Park Management (General Management Plan, Resource Management Plan):

PUHE management documents include a resource management plan from the late 1990's, with a 2003 compendium, development conceptual plans from the late 1980's, a 2001 draft fire management plan, and a 1990's new site proposal for a new visitors center. Cultural resources have been the primary management concern in Puukohola Heiau National Historic Site. The Park intends to maintain Pre-European native land use patterns with management emphasis on replacing the more common plant aliens with culturally important or endemic species.

Park management documents (General Management Plan, Resource Management Plan, etc.) are available on-line at the NPS intranet site (www1.nrintra.nps.gov/im/units/pacn/parks/mgmt_docs.htm). This website is available only from NPS computer networks. Inquiries about public access should be directed to the park.

Natural Resource Management Issues: Alien species are a management concern as they threaten archeological features and may deplete groundwater resources. While eradication is probably impossible, research is needed to find a reasonable means of controlling alien grasses. Recommendations for the restoration and/or reintroduction of native plants are needed.

Surveys are needed on wildlife resources in and adjacent to the park. The extent to which rare and endangered species of wildlife, including monk seals (*Monachus schauinslandi*) and hawksbill turtles (*Eretmochelys imbricata*), use offshore park areas is uncertain. Management also seeks means to reduce sedimentation in the bay. A high priority is a complete inventory of the brackish water systems of the park, their biota, and conditions along with the extent, type and point sources of pollution that lead to eutrophication. Oral history accounts state that Makeahua Gulch (stream) had a perennial flow. Currently the stream flows in the lower reaches only during floods. A survey is needed of the diversion of water from the watershed and evaluation of the impacts of water removal on stream flow throughout the year.

INVENTORIES

Existing & Ongoing Inventories in Park

Vegetation: A checklist of all plant species located within the Puukohola Heiau National Historic Site was compiled in 1975-1976 (Macneil and Hemmes, 1977). A total of 50 species from 21 Angiosperm families were recorded along with two ferns and one Basidiomycete. Of the total number of species collected, 38 were introductions, 10 were indigenous, and 5 were endemic. Macneil and Hemmes (1977) sampled roadside vegetation with quadrats on short transects, and these might be relocated or replicated for a long-term (>25 years) monitoring program.

The plant community was surveyed again in 1996 (Pratt and Abbott, 1996). Results demonstrated that the current vegetation cover of PUHE is predominantly alien. Of 104 vascular plant species found in the survey, 67% were alien species. The checklist was further revised by Pratt in 1998 to include a total of 124 species documented in the Park (Pratt, 1998).

In 1989 an endangered fern study was initiated at PUHE on the pololei, (*Ophioglossum concinnum*). In 1993 a technical report was published by the University of Hawaii (Lipp, 1993) that discussed the possibility that the Hawaiian endemic was actually a species with broad distribution. Scanning electron microscope studies were conducted on the spores of plants collected at PUHE and corroborated that the pololei (now called *Ophioglossum polyphyllum*) is a cosmopolitan species and does not need special protection (Smith 1996).

A study was initiated between 1998 and 2003 to see if fire can be used as a management tool to increase establishment and cover of pili grass (*Heteropogon contortus*). Results were inconclusive, warranting further study (Daehler, 2003).

Terrestrial Vertebrates: Morin (1996) documented 16 bird species in surveys conducted over four different months in 1992-1993. Sixteen bird species were detected during four surveys made during 1992 and 1993. Two of the species (12% of total) were indigenous migratory shorebirds and the other fourteen (88%) were introduced non-native species. The paucity of indigenous avifauna and the complete absence of endemic species can be attributed directly or indirectly to human influences.

Rats, mice, mongooses, feral cats, rat, goats, and chickens have been observed in the park by staff. All are invasive.

During the summer of 2004 an amphibian survey was conducted in the West Hawaii parks. The focus was on identifying what species are present, and collecting voucher specimens. The house gecko was by far the most dominant species at the Park, a pattern not observed at the other West Hawaii parks (Bazzano, 2005)

The inventory and monitoring program sponsored a bat inventory in the West Hawaii parks over a 5 month period with approximately 2 nights every other week at PUHE. Only 1 sighting was made, in the Spencer Beach parking lot just adjacent to park boundaries.

Water Quality: A baseline water quality data inventory and analysis was conducted by the National Park Service, Water Resources Division.

Geology: Halbig et al (1985) performed a baseline study of soil geochemistry in the Kawaihae area.

Landscape: The park tracks the number of vehicles and people visiting the park. Data is available on the Internet at <http://165.83.32.36/mpur/> PUHE has received approximately

50,000 visitors as a yearly average recently, the second most visited West Hawaii park. Ambient sound was measured for three days in May 2003 in preparation for development of the air tour management plan.

Priorities for New Inventories in Park

Terrestrial Invertebrates: Little is known about the insects present in the park.

Existing Buffer Zone Inventories

Freshwater Communities: A multi-park inventory of the West Hawaii anchialine pools is currently underway, through a cooperative agreement between the USGS and NPS. The parks adjacent freshwater/brackish water systems are severely degraded by human construction and the presence of exotic fish predators. However, the systems still provide valuable habitat and are fished by local fishermen. Past inventories have included work done by Maciolek & Brock (1974).

Marine Communities: Preliminary surveys of the bay were initiated in the 1970's, with subsequent studies in the 1990's. Cheney et al (1977) documented a depauperate fish fauna of only 63 species. They also documented two alien fish species in anchialine pools in the park. In 1996 Brian Tissot completed quantitative sampling of three 50-ft. transects on patch reefs in Pelekane Bay with a list of species and relative abundance of all species compiled for all habitats within the bay (Tissot 1998). The study found a striking decrease in abundance of all plants and animals, associated with major changes in species diversity and composition since the Cheney surveys.

Tissot attributes the faunal reductions to long-term sedimentation stress caused by chronic terrestrial runoff. An additional factor is the reduced ocean circulation in Pelekane Bay associated with massive historical deforestation in the Pelekane watershed and construction of the Kawaihae Harbor revetment. (Tissot, 1998).

In 2003 research by NPS and collaborators began near PUHE and other W. Hawaii parks on the recruitment processes of key coral reef invertebrates and fishes (mainly aquarium species).

NPS Pacific Island Coral Reef Program (PICRP) started work in 2003 with USGS along with contractors for aerial photography, to produce high resolution coral reef habitat classification maps for the West Hawai'i parks and coast. A comprehensive marine GIS data base will be constructed to improve knowledge for monitoring and management of the West Hawai'i reef ecosystem structure. The database will also be used to track trends in ecological and oceanographic processes to detect ecological changes in coral reefs in space and time.

Sharks are often seen in Pelekane Bay, offshore from the Heiau. Grey reef sharks (*Carcharhinus amblyrhynchos*), reef white tip sharks (*Triaenodon obesuss*), and particularly reef black tip sharks (*Carcharhinus limbatus*), frequent Pelekane Bay. Park

personnel occasionally record shark sightings. The number and type of sharks, date and time seen, and approximate position is recorded. Water conditions (calm, choppy, other) and weather (clear sky, air temp) and photos are noted. The earliest data sheet is from Oct. 1979 and the most recent from June 2004 (no data between 1982 and 1990).

Thirteen species of benthic algae were collected by a University of Hawaii study team in 1976 (Ball 1977). All but one was indigenous but no rare or unusual species were found.

Fish Communities: The Inventory and Monitoring program conducted an inventory of fish communities in the West Hawaii parks in 2005.

Water Quality: The Pelekane Bay watershed was identified in Hawaii's Unified Watershed Assessment as a Category I watershed: placing it as one of the State's watersheds in most urgent need of restoration. Soil erosion from the watershed has impaired water quality of Pelekane Bay. Data on multiple parameters, including physical, organic, and metals, have been collected from 4 streams in the PUHE watershed by US Geological Survey. A baseline water quality data inventory was conducted by the National Park Service, Water Resources Division, which included areas adjacent to the park boundaries.

Geology: Gardiner studied soils in the Kohala region (Gardiner, 1967), as did Giza (Giza, 1979)

Priorities for new Buffer Zone Inventories

Native Freshwater Communities: A better understanding is needed of the dynamics of the freshwater communities at PUHE, including baseline data on species present, salinity and changes in community with changes in hydrologic conditions.

MONITORING

Previous and On-going Monitoring in Park

Climate: Weather observations at the park are recorded daily and reported to the National Weather Service. Hard copies of the observations are maintained at the park. The data are available online via the National Climatic Data Center website <http://www4.ncdc.noaa.gov/ol/climate/stationlocator.html>. Parameters measured include maximum and minimum temperature, temperature at time of observation, and precipitation. Park staff indicate that the observations have been maintained since the establishment of the park.

Soundscape: Beginning in approximately 1986, park maintenance personnel recorded the presence of helicopters or other aircraft overhead. The concern is that sound vibrations could damage the un-mortared walls of the cultural sites, and impact visitors experience.

A management report dated 10/25/02 states that “No data on helicopter overflights was collected over the last 5-7 years. As an estimate however, compared to the previous reported number of 930 overflights, a significant decrease has been noticed and we would guess about 350 overflights are occurring annually.”

Priorities for New Monitoring in Park

Terrestrial Vertebrates:

More extensive monitoring of bird populations needs to be extended over the year to gain a better understanding of potential use by rare species.

Soundscape: PUHE staff are no longer systematically monitoring overflights. Park staff have met with military and Federal Aviation officials to discuss Memorandums of Understanding for overflight issues. Agreements are in place for military pilots to keep a prescribed distance from the site. However, with increasing development in the tourism traffic and population base, harbor and military facilities, it could be important for the Park to have a system in place to note overflights, and violations of the Memorandum of Agreement.

Existing Buffer Zone Monitoring

Native Marine Communities:

Kawaihae Coral Transplant and Monitoring Project: Corals were collected and moved with hanging baskets away from the “footprint” of the new breakwater. At each of the eight transplant sites, there were four sediment traps to monitor suspended matter settling on the reef (Jokiel et al, In Review). The transplant sites were suboptimum habitat (since prime habitat was already colonized). The corals survived the transplant operation but subsequently succumbed to adverse conditions and storm destruction.

Water Quality: Hawaii State Department of Health (DOH) monitors monthly for *enterococci* and *C. perfringens* at Kawaihae Harbor to the North and Spencer State Beach Park adjacent to the South boundary. Portable meters are also used at these collection sites to measure temperature, salinity, turbidity, dissolved oxygen, and percent dissolved oxygen. The EPA implemented their Hawaii coastal EMAP in 2002 which included 2 randomly selected sites near PUHE. The USEPA updated the 2002 Hawaii coastal EMAP sample design to include open coastal areas as well as embayments in the 2004 assessment. Preliminary site selection maps indicate one reserve sampling location which may be close to PUHE. Sample collection has been delayed until early in 2005.

Geology: Rain gauges and check dams have been installed to monitor the Pelekane watershed by the Mauna Kea Soil and Water Conservation District, and automatic sampling devices to measure flow rate and turbidity upon flood events and at regular intervals when the stream is active.

The operational objective of the Tsunami Warning System (TWS) in the Pacific is to detect and locate major earthquakes in the Pacific region, to determine whether they have generated tsunami, and to provide timely and effective tsunami information and warnings to the population of the Pacific to minimize the hazards of tsunami, especially to human life and welfare. To achieve this objective, the TWS continuously monitors the seismic activity and ocean surface level of the Pacific Basin (Parks: HAVO, HALE, PUHE, PUHO, KAHO, KALA). PUHE has a time lapse camera which can be set up to monitor surf at times of high surf or tsunami warnings. Photos are available from 1988.

Priorities for new Buffer Zone Monitoring

Native Marine Communities: The gathering of sharks in Pelekane Bay represents an important biotic dynamic and presents a research opportunity to gather data on shark behavior. The relationships between shark concentrations, congregations of prey populations, watershed water quality, and sedimentation need to be studied. Better baseline data on shark presence and behavior is needed to monitor and manage impacts. Better understanding of the presence of sharks in Pelekane Bay could enable the park to advertise PUHE as a place to see sharks, creating a stronger visitor draw to the Park, and attracting those sectors of the visitor population less interested in cultural sites.

It is not known to what extent turtles or the monk seal currently use Pelekane Bay, although they have been sighted in the bay in past studies. Therefore, the use of the Bay by hawksbill and green turtles, and the Hawaiian monk seal should be investigated. Green turtles are seen often at the adjacent Spencer Park. Long term monitoring of the health of the coral reef and associated fish populations should be implemented.

Geology: A study is needed of erosion and sedimentation rates in the Pelekane Bay watershed.

Water Quality: The Pelekane Bay watershed project is losing its funding from the State Department of Health. Conditions in the upper watershed greatly impact the parks water quality and the offshore marine waters. There is a great deal of stored sediment in the upper watershed which is released during flood events. Without continued monitoring, it will be difficult to maintain momentum for efforts to improve grazing practices in the upper watershed.

CONCLUSION

PUHE is the smallest of the Hawaiian national parks and is in several ways the most human impacted. The park's watershed and estuarine/marine area have been heavily impacted by harbor construction, past human activities and upstream grazing, leading to erosion and sedimentation. The vegetation is dominated by exotic plants, as is true in the other West Hawaii parks. However, the parks smallness and surrounding development pressures also present opportunities for innovative projects in research, restoration and integration. The cultural sites at the park are

very sacred to native Hawaiians and are still used for traditional ceremonies, making the park a vital link in the continuity of the Hawaiian culture.

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